

## **QUANTIFICATION OF IN-FLIGHT PHYSICAL CHANGES: ANTHROPOMETRY AND NEUTRAL BODY POSTURE**

K. S. Young<sup>1</sup>, R. Amick<sup>1</sup>, S. Rajulu<sup>2</sup>

<sup>1</sup>Lockheed Martin, <sup>2</sup>NASA Johnson Space Center

Currently, NASA does not have sufficient in-flight anthropometric data to assess the impact of changes in body shape and size. For developing future planetary and reduced-gravity suits, NASA needs to quantify the impacts of microgravity on anthropometry and body posture to ensure optimal crew performance, fit, and comfort. To obtain data on these changes, circumference, length, height, breadth, and depth for body segments (chest, waist, bicep, thigh, calf) from astronauts for preflight, in-flight, and post-flight conditions needs to be collected. Once these data have been collected, preflight, in-flight, and post-flight anthropometric values will be compared, yielding microgravity factors. The neutral body posture (NBP) will also be measured, to determine body posture (joint angle) changes between subjects throughout the duration of a mission. Data collection, starting with Increments 37/38, is still in progress but has been completed for 6 out of 9 subjects.

NASA suit engineers and NASA's Extravehicular Activity (EVA) Project Office have identified that suit fit in microgravity could become an issue. It has been noted that crewmembers often need to adjust their suit sizing once they are in orbit. This adjustment could be due to microgravity effects on anthropometry and postural changes, and is necessary to ensure optimal crew performance, fit, and comfort in space. To date, the only data collected to determine the effects of microgravity on physical human changes were collected during Skylab 4, the Apollo-Soyuz Test Project (ASTP), Space Shuttle mission STS-57, and a recent HRP study on seated height changes due to spinal elongation (Spinal Elongation, Master Task List [MTL] #221). The Skylab 4, ASTP, and the STS-57 studies found that, according to photographs, a distinct NBP exists. The still photographs showed a distinguishable posture with the arms raised and the shoulders abducted; in addition, the knees are flexed, with noticeable hip flexion, and the foot is plantar flexed [1,2]. This combination is considered to be the standard set of body joint angles for an NBP in microgravity. A recent simulated microgravity NBP study [3] showed individual variability and inconsistencies in defining NBP. This variation may be influenced by spinal growth, and other potential anthropometry factors such as spinal curvature, age, and gender. Data on the variation of this posture data is required for all kinds of space device designs (such as suits, habitat, and mobility aids). The method proposed in this study considers the dynamic nature of body movement and will use a measurement technique to continually monitor posture and develop a probability likelihood of the neutral posture and how the NBP postures are affected by anthropometry.

Additionally, Skylab studies found that crewmembers experienced a stature growth of up to 3%. The data included 3 crewmembers and showed that a biphasic stature growth occurs once the crewmember enters into weightlessness. However, the HRP Spinal Elongation study showed that crewmembers could experience about a 6% growth in seated height and a 3% stature growth, when exposed to microgravity. The results of that study prove that not all anthropometric measurements have the same microgravity percent growth factor. For EVA and suit engineers to properly update the sizing protocol for microgravity, they need additional anthropometric data from space missions. Hence, this study is aimed at gathering additional in-flight anthropometric measurements, such as length, depth, breadth, and circumference, to determine the changes to body shape and size caused by microgravity effects. It is anticipated that by recording the potential changes to body shape and size, NASA will develop a better suit sizing protocol for the International Space Station and other space missions. In essence, this study will help NASA quantify the impacts of microgravity on anthropometry to ensure optimal crew performance, fit, and comfort. This study will use standard anthropometry data collection techniques, 3D laser scanning, digital still photography, and video data, and perform photogrammetric analyses to determine the changes that occur to the body shape and size, and to NBP, when the human body is exposed to a microgravity environment.

### **REFERENCES**

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